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Abundance of Iceland Scallops in NAFO Div. 4R (Strait of Belle Isle) Declines Further in 1995

by

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ABSTRACT

From its inception the Strait of Belle Isle Iceland scallop fishery has been characterized by four strong peaks in landings (1972-73, 1980-81, 1984-86, and 1992 to present). In the past, each pulse was followed by several consecutive years of poor catches. Nearly one quarter (5,383 t round or 24%) of all removals (22,581 t) from this fishery came from the past three years (1993-95). Nominal catch in each of the last four years has exceeded the overall 27-year average of 836 t. In 1993 and 1994, removals were well over twice the annual mean.

Using a better estimate of landings per unit effort (lb/tow) we now estimate a further 32% decline in 1995 from the 30% reduction already noted for between 1993 and 1994.

A research vessel survey in 1995, the first in eight years, showed that catch rates were low throughout. The stock now appears to be mostly composed of pockets of residual cohorts consisting primarily of large scallops. Scarcity of juveniles throughout the area surveyed (847 mi^2) suggests that prospects for significant and extensive recruitment events in the short- to medium-term are poor.

Six scallop aggregations were identified. Cumulative minimum dredgeable biomass within these patches is estimated to be between 2,000-2,800 t ($\bar{x}$ = 2,400 t). However, scallop densities are low throughout. The stock has probably reached a level of abundance so low as to now require a rebuilding strategy.

RÉSUMÉ

Depuis ses débuts, la pêche du pétoncle d'Islande dans le détroit de Belle-Isle a été caractérisée par quatre grands pics de débarquements (1972-1973, 1980-1981, 1984-1986 et 1992 à aujourd'hui). Dans le passé, chacune de ces poussées a été suivie par plusieurs années consécutives de faibles prises. Près d'un quart (5 383 t, poids entier, ou 24 %) de tous les prélèvements (22 581 t) de cette pêche ont été réalisés au cours des trois dernières années (1993-1995). Au cours des quatre dernières années, les prises nominales ont excédé chaque année la moyenne globale sur 27 ans, soit 836 t. En 1993 et 1994, les prélèvements dépassaient plus de deux fois la moyenne annuelle.

En utilisant une meilleure estimation des débarquements par unité d'effort (lb/trait), nous pouvons maintenant estimer qu'il s'est produit en 1995 une baisse supplémentaire de 32 %, tandis qu'on avait déjà noté une réduction de 30 % entre 1993 et 1994.

Un relevé scientifique réalisé en 1995, le premier en huit ans, a montré que les taux de capture étaient bas dans toute la zone. Le stock semble maintenant composé surtout de poches de cohortes résiduelles consistant principalement en pétoncles de grande taille. La rareté des juvéniles dans toute la zone étudiée (847 mi^2) permet de penser que les perspectives de poussées notables et larges de recrutement sont médiocres à court terme et à moyen terme.

Six gisements de pétoncle ont été repérés. On estime que la biomasse cumulative dragable minimale dans ces gisements se situe entre 2 000 et 2 800 t ($\bar{x}$ = 2 400 t). Toutefois, les densités sont faibles dans toute la zone. Le stock est probablement tombé à un niveau d'abondance si bas qu'il nécessite maintenant une stratégie de rétablissement.

Introduction

The Newfoundland fishery for Iceland scallops is relatively new. It began in the northeastern Gulf of St. Lawrence in 1969. Prosecuted exclusively by vessels under 65 ft LOA, the fishery is characterized by four strong peaks in landings; 1972-73; 1980-81; 1984-86; and the most recent one beginning in 1992 (Fig. 1). A total of 22,581 t round has been harvested in the 27 years with a mean annual removal of 836 t (Table 1). Nearly one-quarter (5,383 t or 24%) of all removals came from the past three years when directed fisheries in other sectors continued to languish.

Very little research effort had been directed into this fishery since 1987. A 9-day research mission in 1987 had suggested that resource depletion had taken place (Lanteigne and Davidson 1987). As predicted, catches in the four years following fell well below the annual mean, as did the nominal effort (Table 1). This trend was reversed in 1992. Concomitant with increased effort, 1,169 t round was landed. Catches have since increased. Beginning in 1993 the main fishing area (Zone 14B) was placed under a management invoked TAC of 1,600 t which was exceeded by 20%. In 1994, the TAC in the traditional fishing area was reduced by 100 t to 1,500 t. Also a pre-emptive supplementary TAC (300 t) was also adopted for an exploratory zone north of the traditional area (Fig. 2, Zone 14A and 14A1).

TACs for both zones had been surpassed; albeit by only 5% in 14B but by 75% in the experimental zone; subsequently it was found that some of the exploratory fishing reportedly in 14A had in fact occurred in 14B; suffice to say, therefore, that the global TAC for 1994 had been exceeded by 15%. Also, misreporting of catches in this fishery is quite common.

In the absence of research vessel information, the 1994 fishery performance had been examined to evaluate resource status (Naidu et al. 1995). This showed that fishing activity, by and large, had returned to areas (scallop beds) once (1970s) considered most prolific. Scallop aggregations have apparently recovered following a prolonged fallow period of up to 20 years. Nominal fishing effort had increased dramatically (Table 1) and exploitation rates were high. A 15% reduction in within-season catch rate was evident (Naidu et al. 1995). Also, overall CPUE had declined 30% from 1993.

It was pointed out that the attractive economic return for this high unit value fishery would tend to favour overexploitation. We had cautioned that continued removals of the order of magnitude seen in the three years preceding would likely result in stock depletion that would render further fishing uneconomic. Also, that the pulse fishing strategy that once was the rule in this fishery would no longer be appropriate as the ability to opportunistically switch to other species is no longer a viable option. Taking these factors into consideration the 1995 TAC for the principal fishing area (14B) was set at 1,500 t, down from the 1994 level of 2,000 t and 1,900 t in 1993. Zone 14B was modified to include all areas, including the 1994 exploratory fishing area (Fig. 2). Opening date for the exploratory zone (14A) was delayed until the quota in zone 14B had been taken. A TAC of 200 t round had been set for the supplementary zones.

A. 1995 Fishery

The fishery opened on June 12, 1995. It continued to be prosecuted by vessels under 65 ft LOA. Total number of vessels participating declined substantially to 43 from 80 in 1994. The majority (40%) of the vessels were in the 35-44 ft range, followed by vessels under 35 ft (33%) and 45-54 ft (21%). Only three of the 43 vessels were in the 55-64 ft range, down from 10 in this category in 1994. One each in the 35-44 ft and 55-64 ft categories ceased fishing two weeks into the fishery.

The bulk (90%) of the catch in 1995 was shucked at sea and only meats landed, up from 77% in 1994. Despite our efforts to have Statistics Branch employ the species-specific conversion factor (9.2) to estimate round weights from meat weight, a factor of 8.3 (for sea scallops) instead of 9.2 continues to be used. This underestimates removals by at least 10% (Table 2). For historical consistency, however, we too continue to use statistics reported by quota monitoring and Statistics Branch. Even then, irreconcilable differences continue to exist in the data bases (Table 2). Science Branch inspection of fishing logs and sales slip data almost invariably results in higher removals (2-3%) than figures provided by Statistics.

The fishery in 14B closed on October 17, 1995. Nominal catch in 1995 fell short of the TAC for 14B (1,500 t) by 168 t (or 11%). With only 2.7 t reported from the exploratory fishery in 14A, the 200 t TAC for that zone was nowhere close to being reached.

Abundance Indices

Research

A 12-day research vessel survey was completed over the target area in 1995. The survey was a modification of the stratified random survey and consisted of two legs. First, twelve east-to-west transects were run with the ROXANN acoustic ground discrimination system between parallels 51°01'N and 51°55'N (Fig. 3). The classification system accurately identifies sea-bed material types including benthic assemblages containing scallops (Burns et al. 1995) and has been successfully used in Iceland scallop resource delineation on portions of St. Pierre Bank and the eastern Grand Banks of Newfoundland.

Spaced 5 mi apart, these transects covered 225 n mi of sea bottom over 847 mi^2 and took 40.2 hrs to complete. Thirteen fishing sets were then employed to calibrate and groundtruth the system for varying bottom types. While the ROXANN can discriminate an infinite number of different combinations of bottom types, we were interested in distinguishing only favourable scallop bottom from unsuitable bottom. We had hoped that this sequential approach would allow for a more efficient stratification of the area based on bottom type than would a stratified random survey frequently based on some artificial stratifying variable, such as depth. Also, it would have been appropriate for a highly aggregate species such as the Iceland scallop. Upon completion of the ROXANN sweeps, fishing sets were assigned randomly and optimally to reflect distribution of available scallop habitat relative to bottom type encountered.

Frequency of bottom types as determined by ROXANN is summarized in Table 3. In practice, however, we found that most of our 0.5 mi tows were contaminated, frequently by a multiplicity of bottom types (Appendix I). While the conventional approach to stratified surveys calls for delineation of strata prior to sampling (Cochrane 1977) we were obliged to post-stratify our design to adapt the survey to focus on spatially aggregated but separate scallop beds (Sukhatme and Sukhatme 1970).

A total of 102 sets was completed over the target area (Fig. 4). Poor catches were encountered throughout the area surveyed (Table 4). Some 600 mi^2 (out of 847) were deemed unsuitable for scallops. Overall, only six areas containing scallops, some commercial, were identified (Fig. 5). Patch estimates were developed for each and pooled to derive an overall estimate of biomass (Table 5, Fig. 6).

At 20% gear efficiency, biomass in the Strait of Belle Isle is estimated at 10,270-13,955 ($\bar{O}$ = 12,115). At 5% to 10% exploitation rates approximate removals would be in the range of 600 to 1,200 t respectively.

Landings per unit effort (CPUEs)

Three measures of landings per unit effort for the total fishery were examined (i.e. all vessels, effort, all gear) by week (Table 6), by month (Table 7), and for the entire season (Table 8). Because of modifications to the zones, some recomputations of the 1994 data were necessary to make valid area-specific comparisons between years. Overall, catch/tow has declined to 57 lb/tow from 70 lb/tow in 1994, a drop of 19% (Table 7). It is clear that CPUEs have continued to drift downward. Catch rates (lb/tow) in four of the five months for which we have comparable data have dropped. Also, contributions to total catch south of 51°25'N continued to decline into 1995 (from 90% in 1993 to only 46% in 1995, Table 9). Consequently, the fishing effort has become increasingly dispersed (Fig. 7).

While vessels in the smallest size range (<35 ft LOA) managed to maintain catch-rates throughout the season, those in the 35-44 ft and 45-54 ft ranges, which contributed to almost 70% of the 1995 removals, showed a downward trend in CPUE (Table 10).

Removals (12 t) and catch rates (35 lb/tow) from the exploratory fishery in 14A continues to be lower than in the traditional area (read: little room to expand further) (Table 8).

Size Frequencies

Shell height size frequencies from the research vessel survey and port sampling of the catch were quite similar (Fig. 8a, 8b). The majority of scallops was large (86.8 ± 8.6 mm, Table 11).

Meat Count and Meat Yield

Meat weight at size in 4R Iceland scallops is amongst the lowest encountered in the Newfoundland Region (Table 12). Overall meat yield is 10.3% (Table 13) compared to 14.9% on St. Pierre Bank and 14.5% in the Lilly Canyon/Carson Canyon areas along the eastern Grand Banks.

Natural Mortality

Natural mortality computed from the ratio of cluckers to live scallops, is high (Table 14) relative to intrinsic values reported for the species (Mercer 1974, Naidu 1988). This may reasonably be assigned to both incidental mortality and to starfish predation.

Stake holder's perceptions:

The observations made in this document were corroborated by a majority of stake holders during DFO/Industry consultations in April 1995.

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Table 1. Iceland scallop landings and effort statistics[1] from the northern Gulf of St. Lawrence/Strait of Belle Isle. For historical consistency a conversion factor of 8.3 (instead of 9.2) is used throughout.

Year	Landings (t, round)	No. of active licences	Effort (boat days)	Catch per unit effort (unadjusted) kg (round) /boat day	Catch per unit effort (unadjusted) t (round) /boat/year
1969	224				
1970	173				
1971	151				
1972	2342				
1973	1975				
1974	220	24	269	818	9.2
1975	-	-	-	-	-
1976	-	-	-	-	-
1977	-	-	-	-	-
1978	-	-	-	-	-
1979	406	16	459	885	25.4
1980	1022	14	774	1320	73.0
1981	1380	24	1262	1094	57.5
1982	315	24	413	763	13.1
1983	335	23	485	691	14.6
1984	1374	46	1272	1080	29.9
1985	2297	107	2887	796	21.5
1986	1752	88	2270	772	19.9
1987	1029	57	na	-	18.1
1988	403	30	na	-	13.4
1989	140	14	na	-	10.0
1990	79	11	na	-	7.2
1991	412	24	na	-	17.2
1992	1169	72	na	-	16.2
1993	1914	71	na	-	26.9
1994	2105	80	2769	760	26.3
1995	1364	43	2113	646	31.7

na = not available

[1] Sources of landing and effort statistics:
1969-81: CAFSAC Res. Doc. 82/02
1982-83: CAFSAC Res. Doc. 86/77
1984-90: Can. MS Rept. 2154
1990-92: Science Branch, Gulf Region
1993 : Statistics Branch, Newfoundland Region
1994-95: Science Branch, Newfoundland Region

Table 2. Estimates of removals (t, round) of Iceland scallops from the northern Gulf of St. Lawrence, 1995.

Area	TAC (t, round)	Statistics Branch (x8.3)	Science Branch (x8.3)	Science Branch (x9.2)
14B traditional	1500	1332.5	1352.0	1484.0
14A exploratory zone	200	2.7	11.9	13.2
TOTALS		1335.2	1363.9	1497.2

Table 3. Summary of parameters used in estimating fishable biomass of Iceland scallops in the Strait of Belle Isle (1995).

	1	2	3	4	5	6	Total
No. sets by strata	4	20	4	50	7	17	102
Total catch (kg) in each stratum	10.24	124.11	9.8	375.93	13.97	1.08	535.13
Mean catch (kg)/tow	2.56	6.21	2.45	7.5	2	0.06	5.24
No. track points (scallop bottom)	189	1272	302	4023	229	354	6369
% scallop bottom	36.63	47.86	49.75	57.58	21.03	14.05	44.3
No. track points (hard & soft bottom)	327	1386	305	2958	822	2153	7951
% hard & soft bottom	63.37	52.14	50.25	42.34	75.48	85.47	55.31
Total track points	516	2658	607	6987	1089	2519	14376
Nautical mi^2	4.5	37.9	4.6	162.2	39.2	598.7	847.1
% of total area surveyed	0.53	4.48	0.54	19.15	4.63	70.67	100

Table 4. Mean numbers and weights (kg, round) of Iceland scallops per tow on W. TEMPLEMAN research trip #174 in northern Gulf of St. Lawrence, August 1995.

Depth fished (m)		No. of sets	Mean number (±S.D.)	Mean weight (±S.D.)
Mean	Range			
69.3	35-110	103	51.3 (±52.1)	5.3 (±5.2)

Table 5. Estimates of minimum dredgeable biomass (kg, round) of Iceland scallops in the Strait of Belle Isle (Div. 4R) in 1995.

Stratum	No. sets	Total	Av. set	Units	Total weight	Variance
1	4	10.24	2.56000	6840	17511	10.6905
2	20	124.11	6.20550	57610	357498	42.7183
3	4	9.80	2.45000	6992	17131	4.3234
4	50	375.93	7.51860	246552	1853727	18.7786
5	7	13.97	1.99571	59586	118917	4.5777
6	17	1.08	0.06353	910054	57815	0.0466

Total	Upper	Lower	Mean	Upper	Lower	Effective degrees of freedom
2,422,599	2,791,337	2,053,860	1.88143	2.1678	1.59506	82

Table 6. Iceland scallop catch rates for area 14B for 1995. (All vessels, all gears).

Week	Dates	Catch (round) per unit effort		
		lbs/day	lbs/hr	lbs/tow
1	June 12-18	1,686	193	61
2	June 19-25	1,502	183	57
3	June 26-July 2	1,286	173	53
4	July 3-9	1,286	171	56
5	July 10-16	1,477	169	56
6	July 17-23	1,533	171	58
7	July 24-30	1,446	181	58
8	July 31-Aug. 6	1,595	187	62
9	Aug. 7-13	1,552	181	59
10	Aug. 14-20	1,272	196	57
11	Aug. 21-27	1,622	185	62
12	Aug. 28-Sept. 3	1,569	174	59
13	Sept. 4-10	1,395	162	54
14	Sept. 11-17	1,020	164	49
15	Sept. 18-24	1,172	150	54
16	Oct. 10-17	824	112	46
	1995 Overall	1,431	175	57
	% reduction over fishing season	51%	42%	25%

Table 7. Monthly CPUE estimates for the Iceland scallop fishery in the northern Gulf of St. Lawrence, 1994 and 1995. [1994 data reexamined to make area-specific comparisons.]

Year	Month	Removals (t, round)	Fishing days	CPUE		
				lb/day	lb/hr	lb/tow
1994	May	1.4	3	1065	116	43
	June	755.3	936	1779	195	76
	July	927.1	1192	1715	180	73
	August	229.1	369	1369	149	58
	September	191.4	266	1587	149	59
	October	1.1	3	772	116	58
1994 Totals		2105.4	2769	1677	178	70
1995	June	237.5	352	1488	184	57
	July	462.0	697	1462	173	57
	August	434.8	627	1529	184	60
	September	201.6	364	1221	157	53
	October	16.1	43	824	112	46
1995 Totals		1352.0	2083	1431	175	57
% reduction 1994-95		36%	25%	15%	2%	19%

Table 8. Scallop removals, effort, and CPUE by zone in the northeastern Gulf of St. Lawrence, 1995.

Area	Removals (t, round)	Effort days	CPUE		
			lbs/day	lbs/hr	lbs/tow
14B	1352	2083	1431	175	57
14A	12	30	685	75	35

Table 9. Iceland scallop effort and catch rates (CPUEs) for area 14B south of 51°25'N, 1993-95. Figures in brackets are the percent reduction in catch rate from the previous year.

Year	Percent of 14B totals		CPUE		
	Removals	Days effort	lb/day	lb/hr	lb/tow
1993	90	85	2580	275	-
1994	63	65	1765 (32%)	196 (29%)	84
1995	46	50	1385 (22%)	162 (17%)	57 (32%)

Table 10. Estimates of CPUE's (lb/tow, round) by vessel size class (LOA) during the fishery in area 14B in the northern Gulf of St. Lawrence, 1995.

Week	Dates	<35'	35-44'	45-54'	55-64'	Combined
1	June 12-18	66	57	58	74	61
2	June 19-25	58	61	55	39	57
3	June 26-July 2	49	55	55	20	53
4	July 3-9	53	58	54	49	56
5	July 10-16	57	56	53	56	56
6	July 17-23	56	63	53	59	58
7	July 24-30	63	59	51	62	58
8	July 31-Aug. 6	62	65	57	61	62
9	Aug. 7-13	63	62	50	52	59
10	Aug. 14-20	59	59	50	64	57
11	Aug. 21-27	64	63	54	84	62
12	Aug. 28-Sept. 3	66	59	52	71	59
13	Sept. 4-10	63	51	48	76	54
14	Sept. 11-17	63	47	42	-	49
15	Sept. 18-24	65	50	42	69	54
16	Oct. 10-17	50	42	41	-	46
Overall		60	58	52	60	57
No. vessels		14	17	9	3	43
% (of 14B total) weight removed		28%	46%	22%	4%	100%

Table 11. Mean and modal shell heights (mm) of Iceland scallops in the northern Gulf of St. Lawrence, August 1995.

Div.	N	Mean shell height (mm (±S.D.)	Modal shell height (mm)	Range Max.	Range Min.
4R	3,405	86.8 (±8.6)	90	111	24

Table 12. Size-specific meat weights (g) for Iceland scallops computed from shell height/meat weight regressions.

Shell height (mm)	4R	3L	3Ps	3N
40	1.9	1.4	1.4	1.8
45	2.5	2.0	2.0	2.5
50	3.2	2.6	2.7	3.4
55	3.9	3.4	3.5	4.5
60	4.8	4.3	4.5	5.8
65	5.8	5.3	5.8	7.3
70	6.7	6.5	7.2	9.0
75	8.0	7.9	8.8	11.0
80	9.3	9.4	10.6	13.3
85	10.7	11.1	12.7	15.8
90	12.2	12.9	15.0	18.7
95	13.8	15.0	17.6	21.8
100	15.5	17.2	20.4	25.3

Div. 4R: $\log W = 2.2938 \log SH - 3.3962$ ($r^2 = 0.65$) August 1995
Div. 3Ps:[1] $\log W = 2.9449 \log SH - 4.5795$ ($r^2 = 0.91$) August 1991
Div. 3L:[2] $\log W = 2.7239 \log SH - 4.2112$ ($r^2 = 0.87$) July 1994
Div. 3N:[2] $\log W = 2.8960 \log SH - 4.3889$ ($r^2 = 0.91$) July 1994

[1] Naidu and Cahill 1992
[2] Naidu et al. 1995

Table 13. Biological meat yields, average meat weights and meat count/500 g of Iceland scallops from the northern Gulf of St. Lawrence, August 1995.

Area	N	Whole* wt. (kg)	Meat wt. (kg)	$\bar{x}$ meat wt. (g)	Count (#/500 g)	Yield (%)
4R	921	105.28	10.79	11.7	42.7	10.3

* whole weight = weight of scallops as caught. No barnacles\epibionts cleaned off shells.

Table 14. Natural mortality for Iceland scallops in the northeastern Gulf of St. Lawrence computed from ratio of cluckers to live scallops, August 1995. Clucker numbers are adjusted by a factor of 1.221 to allow for tow-induced disarticulation.

Division	Live	Cluckers	M
4R	3,548	411.5	0.181932

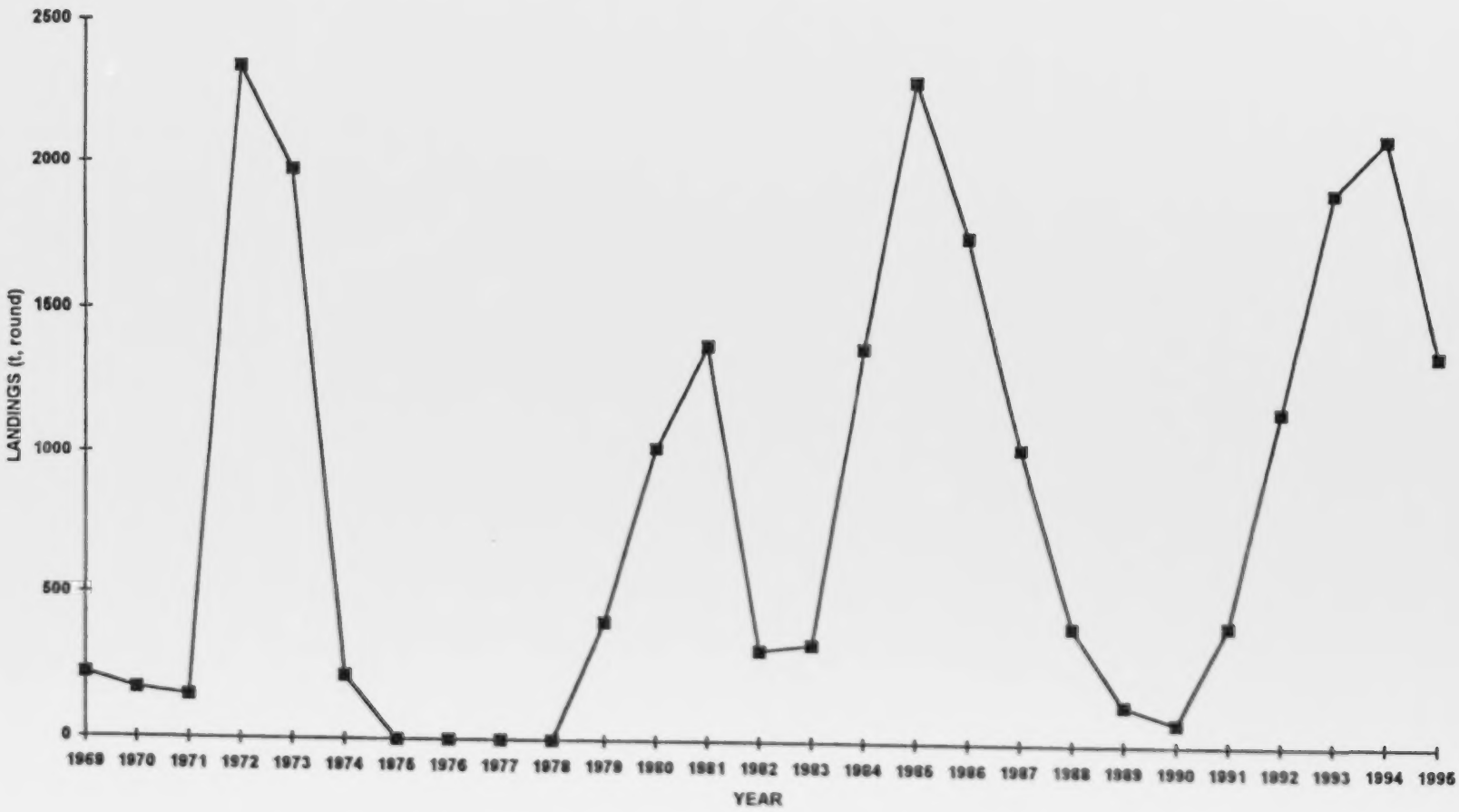

Fig. 1. Landings for northern Gulf of St. Lawrence/Strait of Belle Isle, 1969-95.

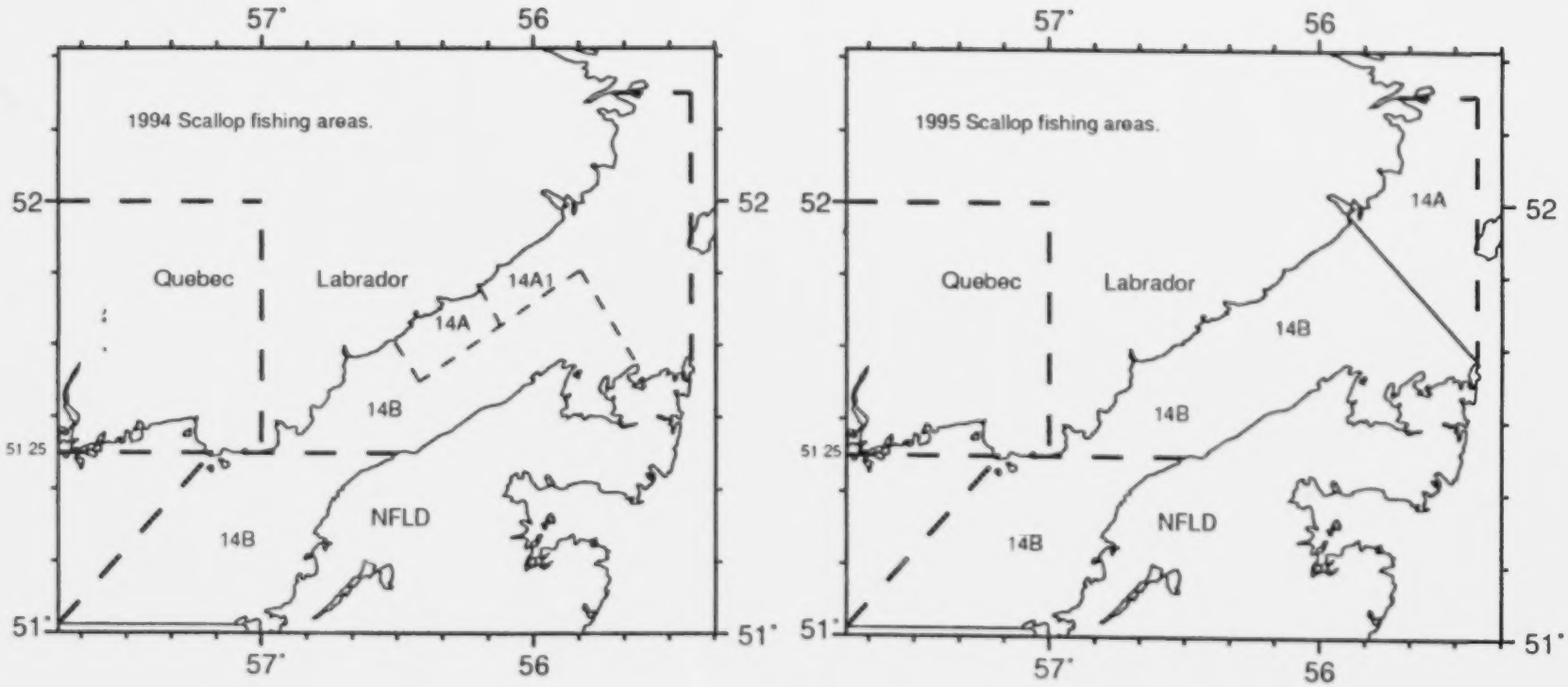

Fig. 2. Iceland scallop fishing zones in the northern Gulf of St. Lawrence, 1994 and 1995.

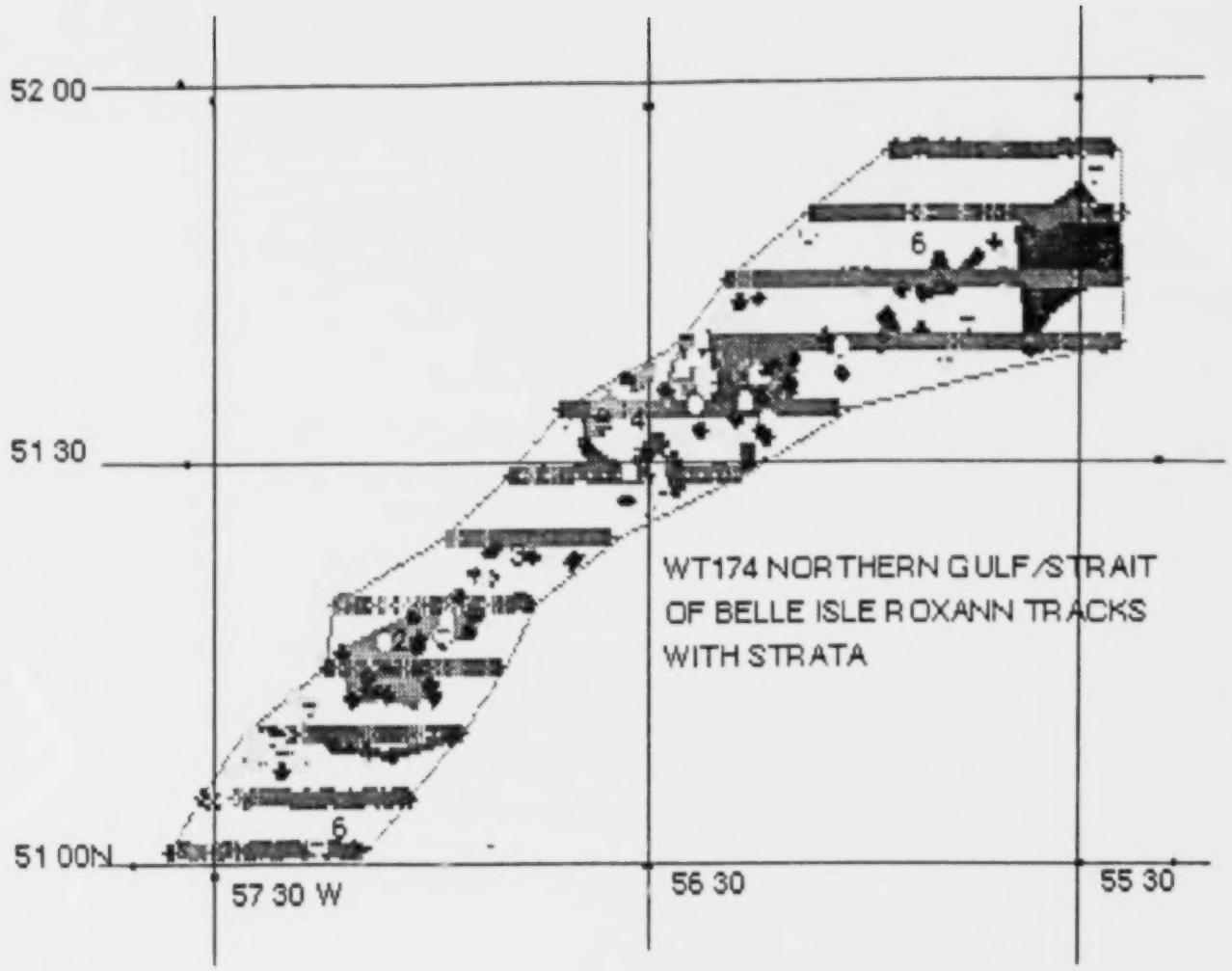

Fig. 3. Northern Gulf/Strait of Belle Isle ROXANN tracks with strata, 1995.

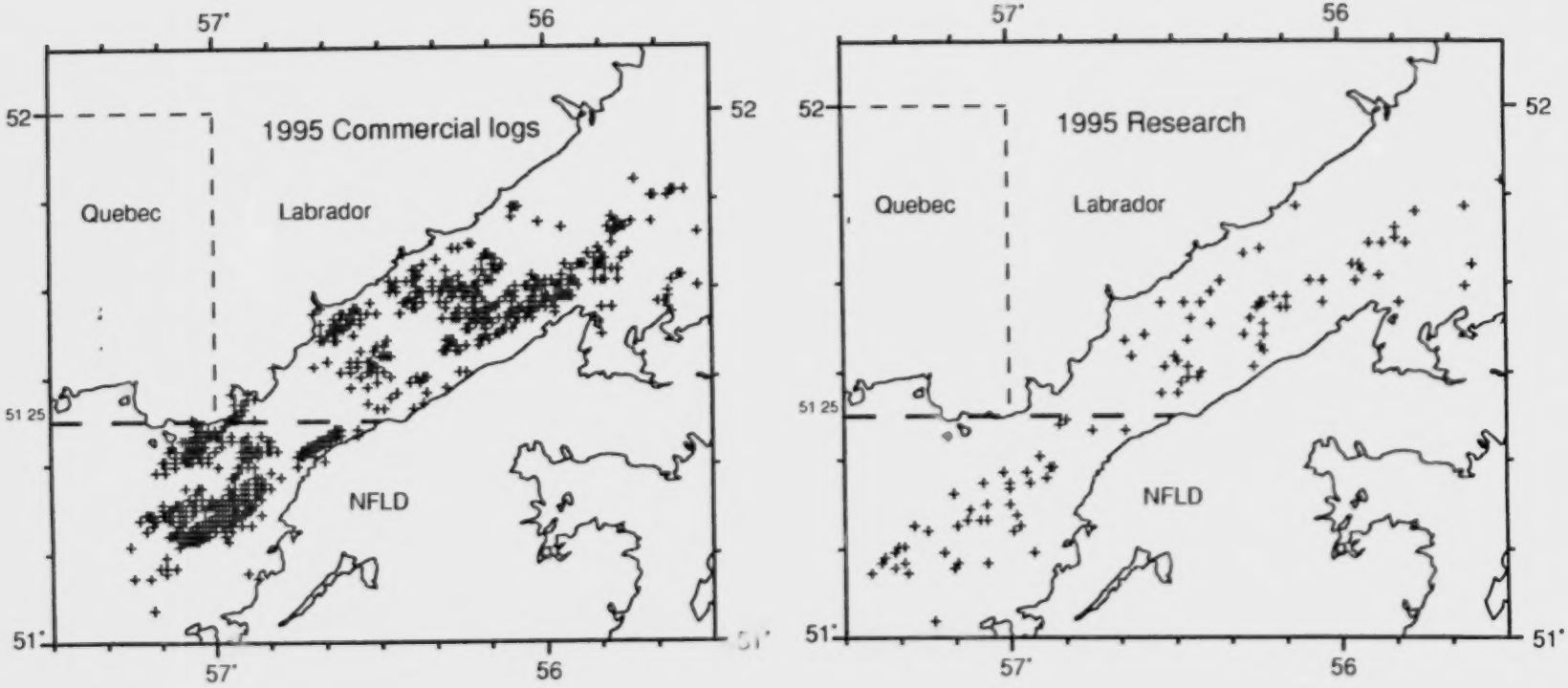

Fig. 4. Distribution of 1995 commercial effort and research stations in the northern Gulf of St. Lawrence.

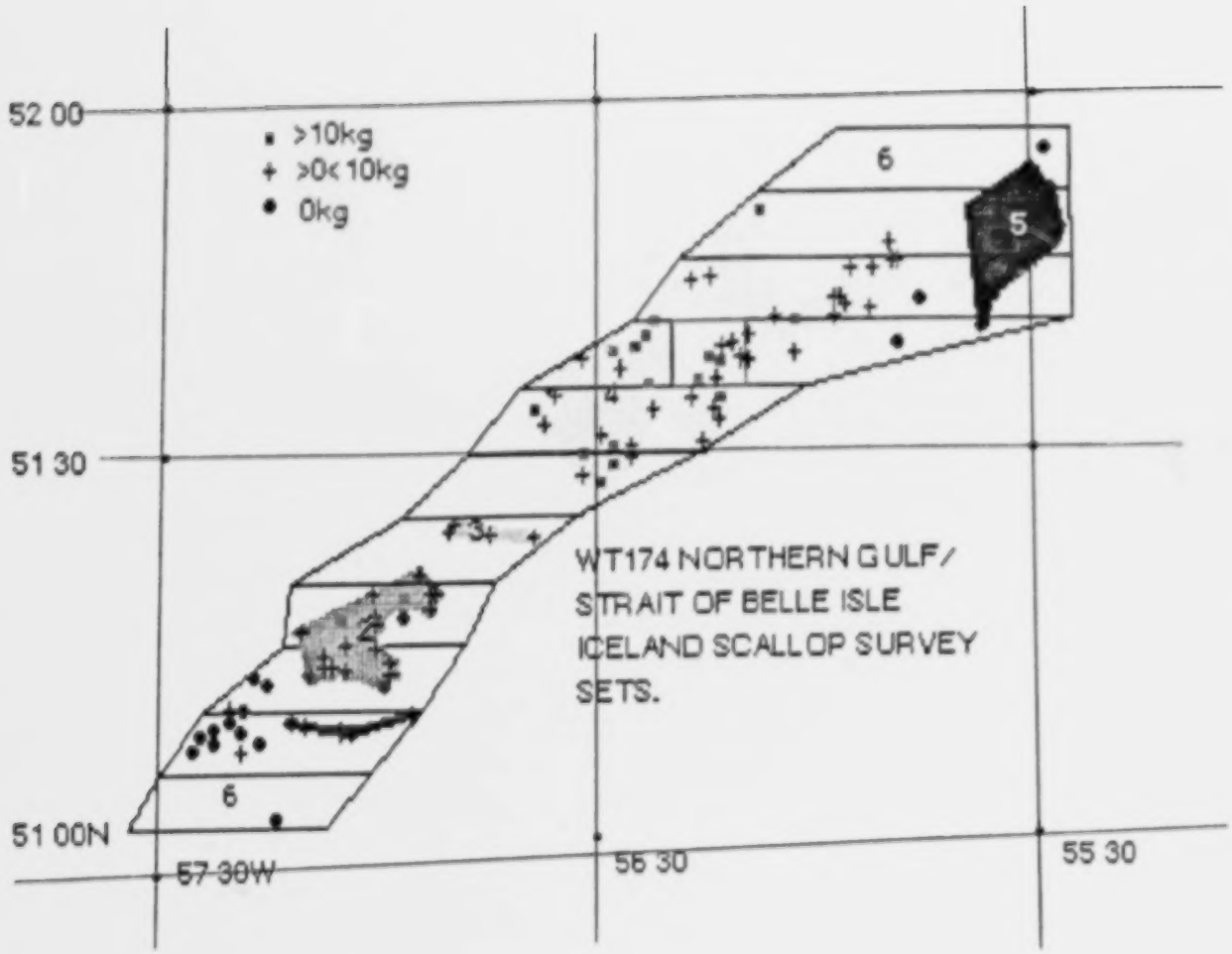

Fig. 5. Distribution of 1995 Iceland scallop survey sets.

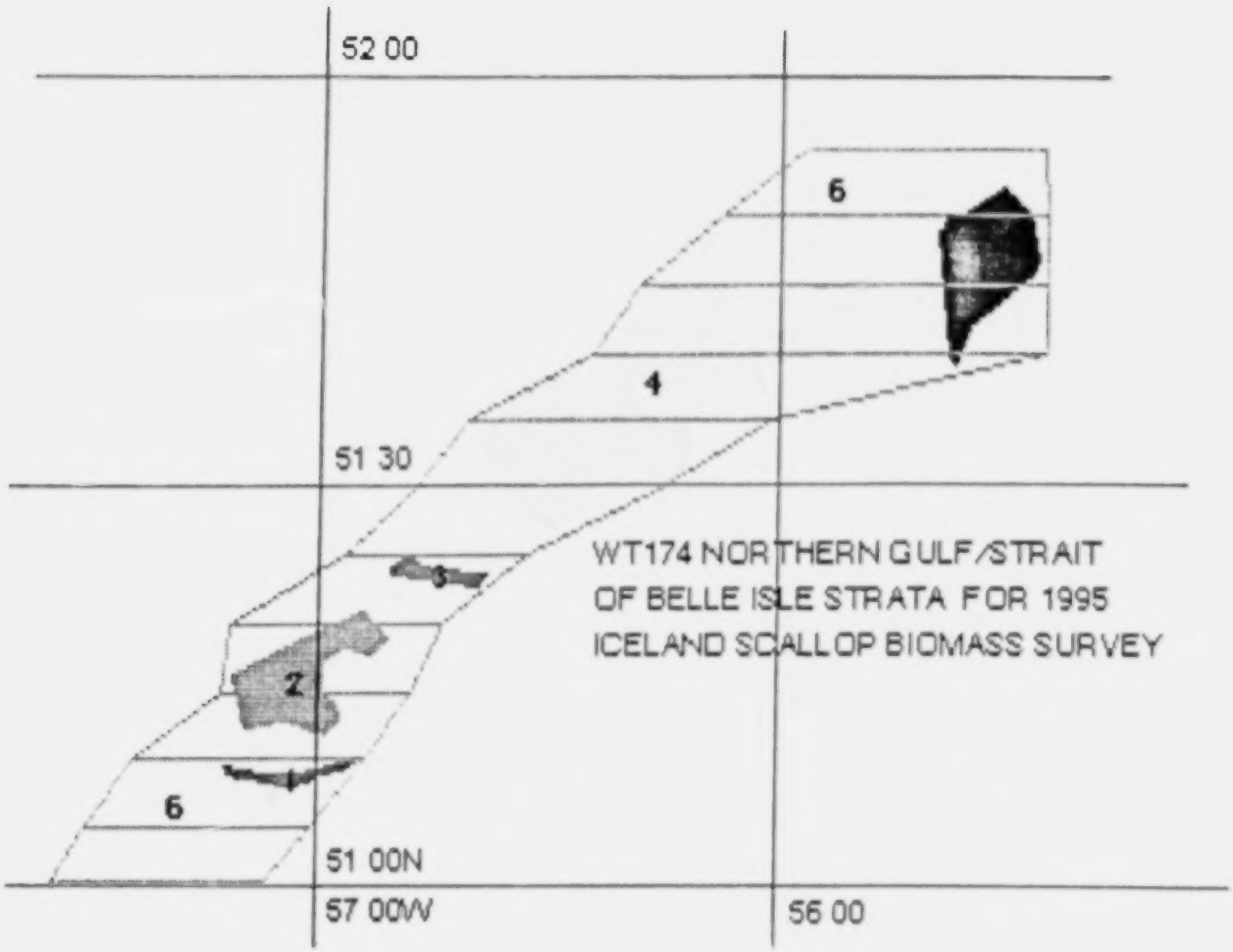

Fig. 6. Stratification scheme used for Iceland scallop biomass estimate in northern Gulf of St. Lawrence, 1995.

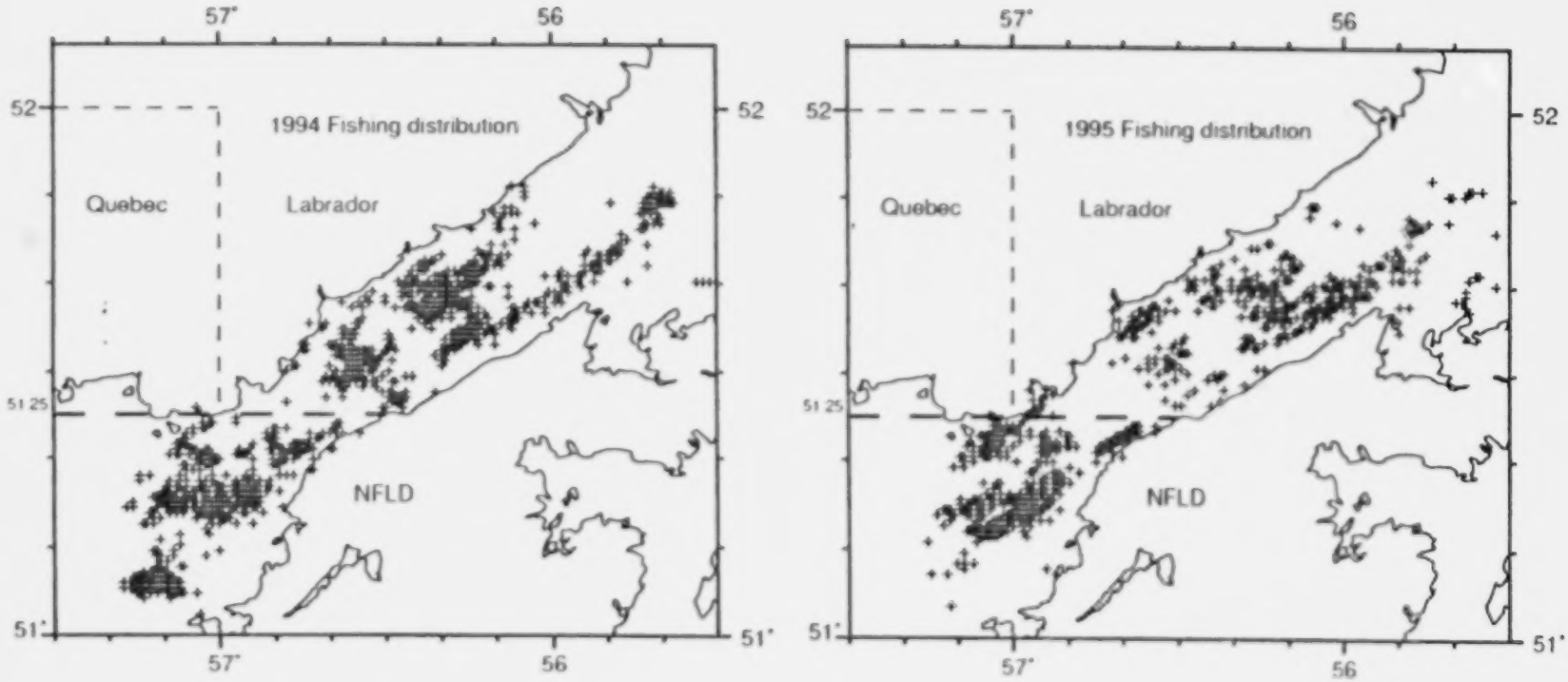

Fig. 7. Distribution of Iceland scallop fishing effort, 1994-95.

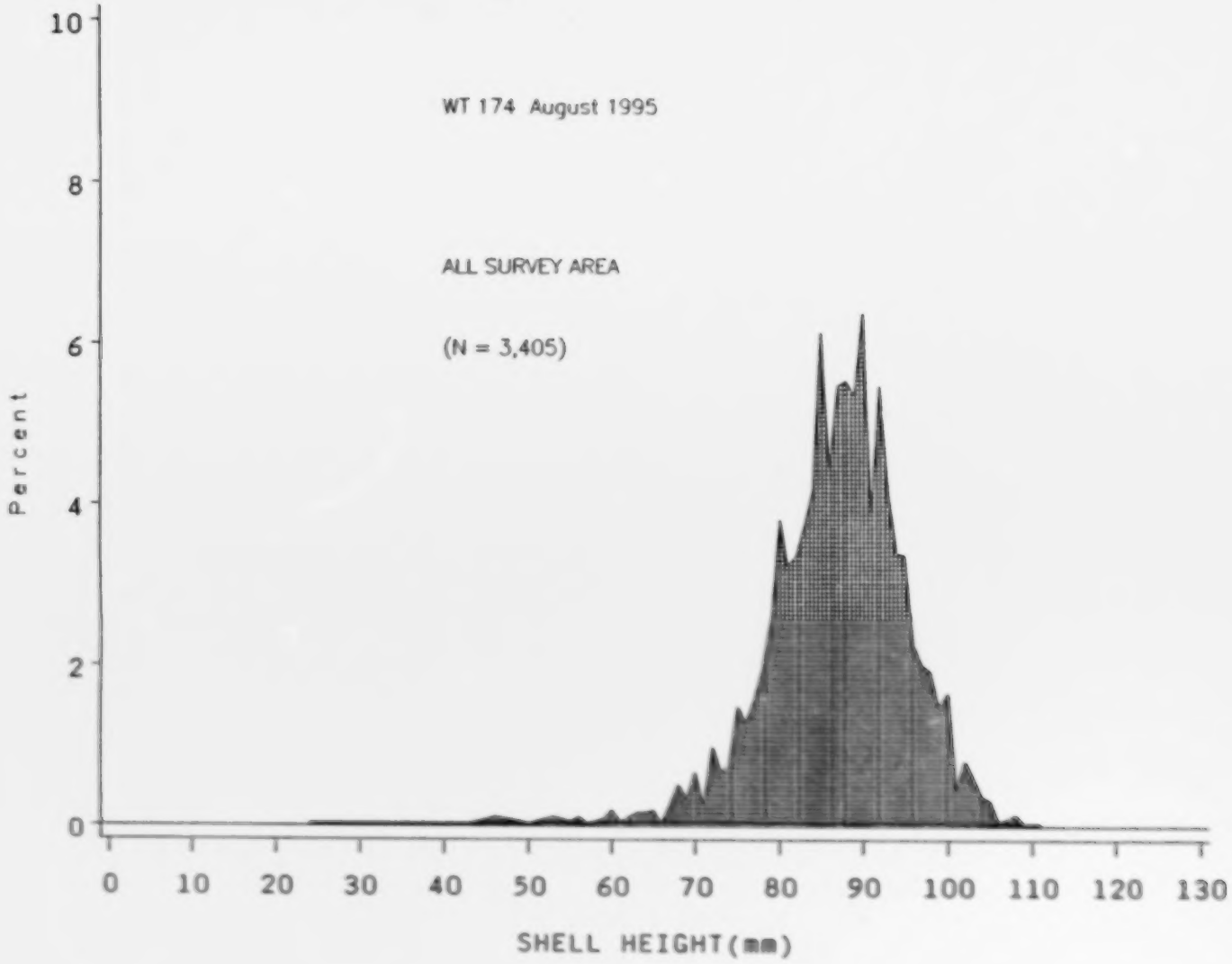

Fig. 8a. Research vessel shell-height frequency for Iceland scallops, 1995.

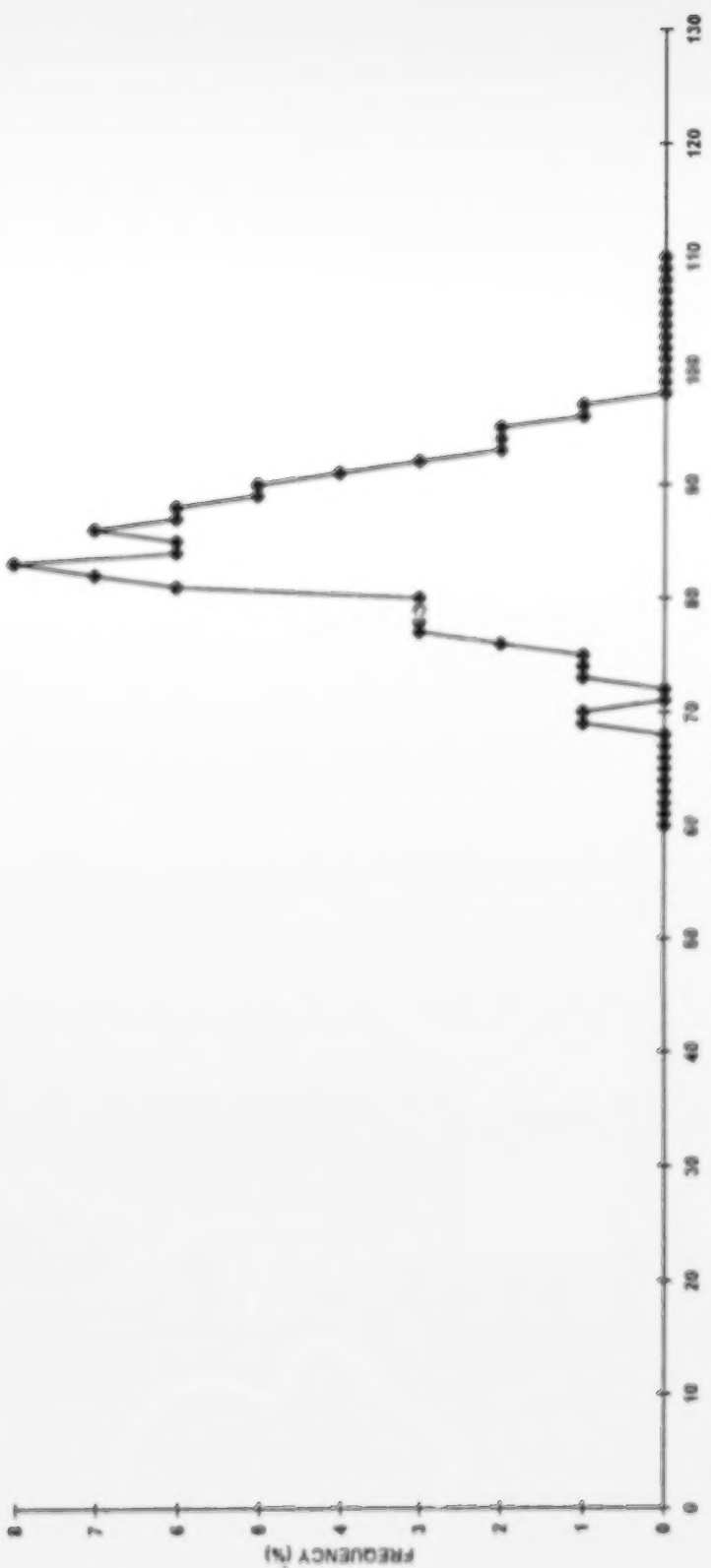

Fig. 8b. Commercial shell-height frequency for Iceland scallops, 1995.